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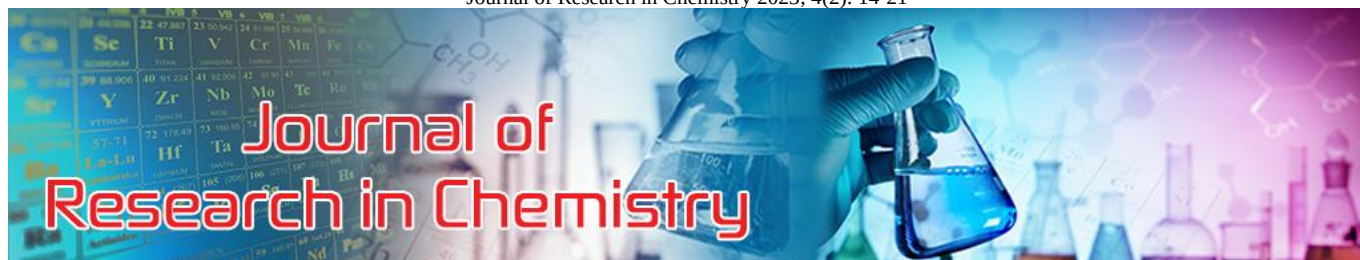


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Hussein Elaibi

Department of Laboratory,
Iraqi Ministry of Health Imam
Hussein Medical City, Iraq

Farah Mutlag

Department of Karbala, Iraqi
Ministry of Education Karbala
Education Directorate
Education Iraq

Zanab Kaream Al-Ebey

Department of Chemistry,
University of Baghdad, College
of Science, Iraq

A comprehensive review of *Aloe vera*: Multifaceted health benefits and anti-diabetic properties

Hussein Elaibi, Farah Mutlag and Zanab Kaream Al-Ebey

Abstract

The main aim is to identify the effectiveness of *Aloe vera* in patients with diabetes mellitus and its effects on skin health and its effectiveness on other diseases. Its gel, composed of various compounds like saccharides, vitamins, phenolics, enzymes, and more, has therapeutic properties, acting as an antioxidant, anti-inflammatory, and antimicrobial agent. *Aloe vera*'s gel is sought after for its wound healing, skin moisturizing, and anti-inflammatory properties. Additionally, *Aloe vera* juice is known to aid digestion and alleviate upset stomachs, benefiting those with digestive issues like constipation and irritable bowel syndrome. The chemical properties of *Aloe vera* reveal a diverse range of compounds, with polysaccharides, anthraquinones, phenolic compounds, vitamins, minerals, amino acids, and enzymes being among the most significant. These compounds contribute to the antioxidant, moisturizing, and laxative effects of the plant. *Aloe vera*'s wide array of health benefits, including detoxification, immune support, antibacterial properties, and potential for aiding weight loss, are attributed to its nutrient-rich content. The *Aloe vera* leaf consists of three layers, each playing a specific role in the plant's function and composition. The amount and type of chemical compounds found in *Aloe vera* can vary depending on various factors such as growth conditions, harvest time, climate, and the specific *Aloe vera* species being examined. *Aloe vera*'s versatile applications extend beyond personal health benefits. It shows potential for environmental processes such as biodegradation, bioremediation, detoxification, and more, making it a valuable natural resource with various practical applications. In the context of diabetes, *Aloe vera* has drawn significant interest in traditional medicine due to its potential anti-diabetic effects. Studies have indicated that *Aloe vera* gel and isolated compounds like anthraquinones may positively impact glucose tolerance and insulin sensitivity. Furthermore, *Aloe vera*'s use in combination with other herbs has shown promise in altering gut microbiota and providing relief from type 2 diabetes symptoms. Overall, *Aloe vera*'s rich chemical composition, extensive medicinal uses, and positive impact on health make it a remarkable natural resource with broad applications in various fields. Moreover, innovative drying techniques, such as microwave-assisted drying, offer efficient alternatives for obtaining *Aloe vera* powder without compromising its bioactivity. The multifaceted benefits and adaptability of *Aloe vera* make it a valuable addition to traditional and modern approaches to health and well-being.

Keywords: *Aloe vera*, anti-diabetic, Vitamins & Minerals

Introduction

Aloe vera (*Aloe barbadensis* Mill.) is a succulent plant renowned for its health-enhancing properties and extensive application in traditional medicine. Globally, it is predominantly employed for managing dermatological issues and promoting skin health, owing to its therapeutic, emollient, antioxidant, anti-inflammatory, antimicrobial, and depigmenting properties [1]. The *Aloe vera* gel is comprised of approximately 99% water and 1% solid material, containing a variety of compounds such as saccharides (Mannose, glucomannan, acemannan), vitamins (B1, B2), phenolics (anthraquinones, flavonoids), enzymes (amylase, carboxypeptidase), and low molecular weight substances (cholesterol, salicylic acid), among others [2, 3]. A variety of solvents, including water, ethanol, methanol, chloroform, and petroleum ether, can be utilized for *Aloe vera* extraction [4]. This plant's gel is highly sought because it can heal wounds, moisturize dry skin, and reduce inflammation [5-7]. The digestive system also benefits from *Aloe vera* [8]. The juice of *Aloe vera* plants might help calm an upset stomach. Constipation and irritable bowel syndrome are two digestive problems that might benefit from this [9-11].

There are several different types of phytochemicals found in the *Aloe vera* leaf. They include phenolic acids/polyphenols, phytosterols, fatty acids, indoles, alkanes, pyrimidines, alkaloids, organic acids, aldehydes, dicarboxylic acids, ketones, and alcohols. Polyphenols,

Correspondence Author:**Hussein Elaibi**

Department of Laboratory,
Iraqi Ministry of Health Imam
Hussein Medical City, Iraq

indoles, and alkaloids make up the bulk of their antioxidant action ^[12-15]. The polysaccharides in *Aloe vera* have been linked to a wide variety of health benefits, and it's thought that many of the plant's biological activities result from a synergistic impact of the many substances found in the leaf ^[16-18]. It has been demonstrated that an aqueous extract of *Aloe vera* generates reactive oxygen species (ROS) ^[19], such as superoxide anion and hydroxyl radicals, and that this generates DNA damage in the presence of copper ions, leading to further apoptosis in cancer cells. It has also been shown that *Aloe vera* can effectively inhibit the development of skin cancer ^[20-23]. The ingredients of the *Aloe vera* plant include Water: It makes up a significant portion of *Aloe vera* gel. Sugars: Such as mannose, glucomannan, and acemannan. Vitamins: Like vitamins B1 and B2. Phenolic compounds: Such as anthraquinones and flavonoids. Enzymes: Like amylase and carboxypeptidase. Low molecular weight substances: Such as cholesterol and salicylic acid.

This substance is both highly affordable and easily accessible. Furthermore, it is non-toxic, safe for biological applications, and environmentally friendly.

The structure of the *Aloe vera* plant consists

The plant bears yellow tubular blooms and fruit with many seeds that are triangular in shape and mushy around the margins. The three layers that make up a leaf are as follows:

1. A water-and-glucomannan-and-amino-acid-and-lipid-and-sterol-and-vitamin-rich interior clear gel ^[24, 25].
2. Anthraquinones and glycosides are found in the intermediate layer of latex, which is the bitter yellow sap ^[26].
3. The third and final layer is the rind, a thick layer of 15-20 cells that serves a protective role and produces carbohydrates and proteins. Water (xylem) and starch are transported by vascular bundles located within the rind (phloem) ^[27, 28]. The amount and variety of chemical compounds found in various types of *Aloe vera* can vary significantly due to factors like growth conditions, harvest time, climate, the position of the leaf on the stem, and even the specific species of *Aloe vera* being considered. These factors all play a role in shaping the unique composition of this remarkable plant ^[29-31].

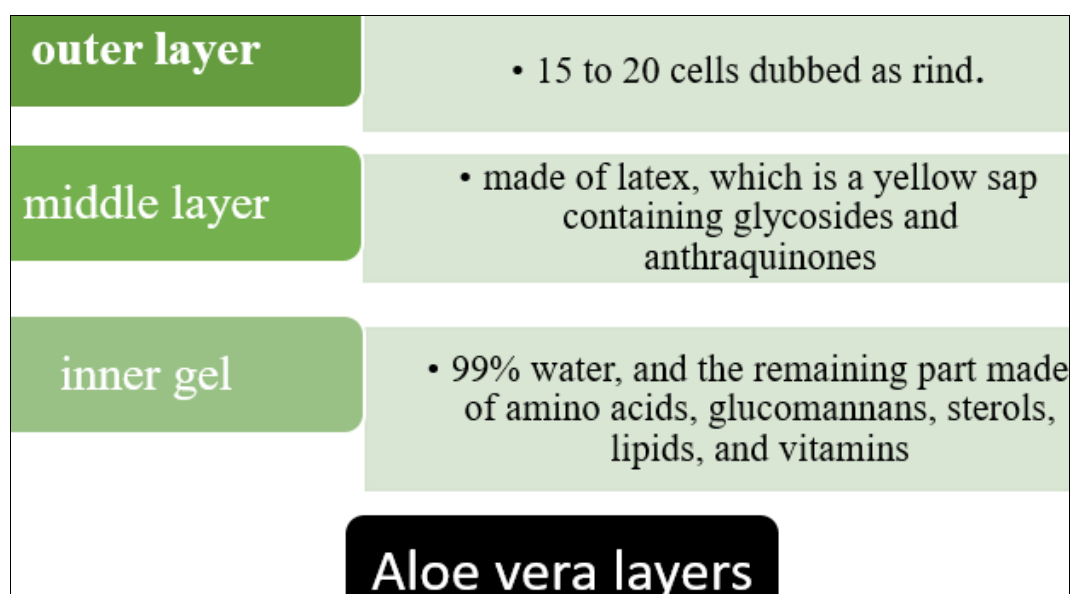


Fig 1: *Aloe vera* layers ^[27]

Chemical properties of *Aloe vera*

Aloe vera plants are quite complex and contain hundreds of different compounds. The total solid content of *A. vera* gel is 0.66%, and soluble solids are 0.56%. Aloe gel contains 55% of polysaccharides, 17% of sugars, 16% of minerals, 7% of proteins, 4% of lipids, and 1% of phenolic compounds ^[32-34]. Among them, the most important compounds are ^[35]:

Polysaccharides: The most abundant compounds in the *Aloe vera* plant are polysaccharides. These compounds are found in the structure of the plant. By increasing the moisture-holding capacity of the plant, polysaccharides moisturize the skin and reduce irritation ^[36, 37].

Anthraquinones

Another important group of compounds found in the *Aloe vera* plant is anthraquinones. These compounds are found in the structure of the plant and provide the plant with a

laxative effect ^[38-40].

Phenolic compounds: Another important group of compounds found in the *Aloe vera* plant are phenolic compounds. The plant's structure and provide the antioxidant effects of the plant ^[41, 42].

Vitamins and minerals: The *Aloe vera* plant contains many vitamins and minerals. These include vitamins such as A, C, E, B1, B2, B3, B6, B12, folic acid, and minerals such as calcium, magnesium, zinc, selenium, and iron ^[43, 44].

Amino acids: The *Aloe vera* plant contains approximately 20 different amino acids. These include essential amino acids ^[45].

Enzymes: The *Aloe vera* plant contains many enzymes such as protease, amylase, lipase, catalase, and superoxide dismutase. These enzymes provide the plant's anti-inflammatory, antibacterial, and antioxidant effects ^[46, 47].

Table 1: Benefits of *Aloe vera*

Terms	Benefits	References
Detoxification	Detoxify harmful toxins from the body	[48]
Vitamins & Minerals	Contains vitamins like Vit A, C, E & B12 Minerals like Ca, Zn, Na, Fe, and K	[49, 50]
Adaptogen	Adaptive & Defence mechanisms of the body	[51, 52]
Digestion	Improves digestive tract	[53, 54]
Immune System	Build Immunity	[55, 56]
Antibacterial and antiviral	Fight against Bacteria and Viruses	[57-59]
Weight loss	Helps to lose weight	[60, 61]
Inflammation	Reduce inflammation	[62]

Table 1 provides a summary of some of the most important advantages of consuming *Aloe vera*, which may be traced back to the plant's high nutrient content [63].

Physio-chemical properties of *Aloe vera*

On the inside of the leaves, *Aloe vera* gel is found in a gel-like consistency. *Aloe vera* gel has a clear or yellowish color. A gel from *Aloe vera* is slightly acidic and contains a pH range between 4.5 and 5.5. In addition to water, sugars, amino acids, vitamins, minerals, enzymes, lignin, and anthraquinones, *Aloe vera* gel contains many different chemical compounds. The *Aloe vera* plant is easily soluble in water and can be used in products that contain water. *Aloe vera* has antimicrobial properties, which can prevent the growth of microorganisms. Proper storage conditions are essential to maintaining the stability of *Aloe vera* products, which may be sensitive to high temperatures or oxidation [64-68].

Innovative microwave-assisted drying techniques for preserving *aloe vera* bioactivity and its diverse environmental and medicinal applications: *Aloe vera* powder is derived from dried leaves, which involves washing the leaf fillets and placing them in a humid chamber with specific temperature and humidity settings. The traditional drying methods can negatively impact the temperature-sensitive bioactive components present in *Aloe vera*. Conversely, freeze-drying or lyophilization can preserve the bioactivity of these ingredients, but they are expensive and time-consuming processes [31, 69, 70]. Fortunately, there are innovative microwave-assisted drying techniques that offer excellent alternatives to conventional freeze-drying. By using microwave heating in combination with a standard drying approach, we can achieve an energy-efficient, cost-effective, and economical method for obtaining *Aloe vera* powder. This approach maintains the bioactivity of the ingredients while avoiding the drawbacks of traditional and freeze-drying methods [31].

Table 2: The following are some instances of how the *Aloe vera* plant might contribute to the processes of bio detoxification, bioaccumulation, bio magnification, biodegradation, and bioremediation:

Environmental Process	Contribution of <i>Aloe vera</i> Plant	References
Biodegradation	Break down organic materials naturally	[71-73]
bioremediation	Remove pollution naturally, for example, it can be used to remove oil pollution	[74-76]
detoxification	Promoting digestive system detoxification, cleansing toxins from the skin	[77-79]
Bioaccumulation	Removal of chemicals from the soil, the plant itself does not cause bioaccumulation	[80-82]
Biomagnification	High levels of chemicals	[83-85]

Table 3: Medicinal Use of *Aloe vera* plant

Health problem	<i>Aloe vera</i> Use	References
Skin problems (acne, eczema, psoriasis, etc.)	<i>Aloe vera</i> gel can be applied topically	[86-88]
Burns and other skin wounds	<i>Aloe vera</i> gel can be applied topically	[89-91]
Digestive system problems (digestive problems, ulcers, constipation, etc.)	<i>Aloe vera</i> juice or supplements can be taken orally	[140-142]
immune system problems	<i>Aloe vera</i> juice or supplements can be taken orally	[95-97]
Cancer	<i>Aloe vera</i> supplements or gel may help alleviate side effects associated with radiation and chemotherapy	[98-100]
Diabetes	<i>Aloe vera</i> supplements or gel may help lower blood sugar levels	[31, 101, 102]
Eye problems (eye infections, dry eye syndrome, etc.)	<i>Aloe vera</i> gel can be applied topically	[103-105]
Hair problems (hair loss, dandruff, etc.)	<i>Aloe vera</i> gel can be applied to the hair	[106-108]

The effect of *Aloe vera* anti-diabetic

Aloe vera has garnered great attention in traditional medicine for the treatment of many diseases including diabetes diseases [31, 109]. *Aloe vera* gel is packed with goodness, providing various benefits like acting as an antioxidant and aiding in diabetes management. Remarkably, it increases the decrease in glutathione levels by an impressive four times in diabetic rats [110]. In a study conducted by Gupta A, Rawat S., *et al.* in 2017 it was

found, According to researchers, *Aloe vera* plants containing polysaccharides have some incredible health benefits. They've found that these polysaccharides can help regulate blood sugar levels, stimulate the production of antioxidants, and even reduce cholesterol. Moreover, *Aloe vera* is excellent at detoxifying the body, removing waste products and toxins, while also enhancing the function of immune cells. People often use *Aloe vera* juice to improve their digestive system, which in turn helps maintain stable blood

sugar levels and facilitates better nutrient absorption ^[111, 112]. In a clinical trial conducted by a group of scientists, they created a unique herbal blend using 8 different herbs, including *Momordica charantia*, *Salvia miltiorrhiza*, *Rhizoma anemarrhenae*, *Aloe vera*, *Coptis chinensis*, *Schisandra chinensis*, red yeast rice, and dried ginger. The incredible result was that this herbal formula had a significant impact on the gut microbiota, bringing about positive changes and providing relief from symptoms related to type 2 diabetes. It achieved this by promoting the growth of beneficial bacteria like *Faecalibacterium* and *Blautia*, which play a crucial role in improving our health ^[113, 114]. Multiple studies have provided evidence that anthraquinones isolated from *Aloe vera* offer a wide range of health benefits. These include anti-diabetic, anti-microbial, and hepatoprotective (liver-protective) ^[115-117]. Anthraquinone appears to improve glucose tolerance and insulin sensitivity by increasing the expression of insulin receptor substrates-1 (IRS-1) and phosphoinositide-3-kinase (PI3Ks) while also influencing metabolic-related genes. Additionally, similar to tetracycline, anthraquinones can disrupt bacterial protein synthesis by blocking ribosomal sites-A, which results in their antibacterial effects ^[118, 119].

Conclusion

Aloe vera (*Aloe barbadensis* Mill.) stands out as a remarkable succulent plant with numerous health-enhancing properties and versatile applications in traditional medicine. With a rich chemical composition comprising polysaccharides, anthraquinones, phenolic compounds, vitamins, minerals, enzymes, and more, *Aloe vera* offers a wide range of therapeutic benefits. From promoting skin health, wound healing, and digestive system support to displaying antioxidant, anti-inflammatory, antimicrobial, and detoxifying properties, this plant has earned its reputation as a natural remedy. The extensive studies on *Aloe vera* have revealed its potential in managing various health conditions, including skin issues, digestive problems, diabetes, immune system support, and even cancer-related side effects. The fact that *Aloe vera* is readily accessible, non-toxic, and environmentally friendly further enhances its appeal as a safe and beneficial resource. Additionally, the innovative microwave-assisted drying technique provides a cost-effective and energy-efficient method for obtaining *Aloe vera* powder while preserving its bioactivity. This opens up new possibilities for incorporating *Aloe vera* into various products and applications. The varied contributions of *Aloe vera* to environmental processes, such as biodegradation, bioremediation, and detoxification, underscore its relevance beyond individual health benefits and its potential to address broader environmental challenges. As we continue to explore and appreciate the complex structure and diverse chemical properties of *Aloe vera*, its relevance in traditional and modern medicine remains significant. With ongoing research and further studies, *Aloe vera*'s potential as a natural, accessible, and effective health-enhancing agent is likely to find even more applications, benefiting humanity's well-being and environmental stewardship.

Competing Interests

The authors have no commercial or other competing interests concerning the review paper.

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Author contribution

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